



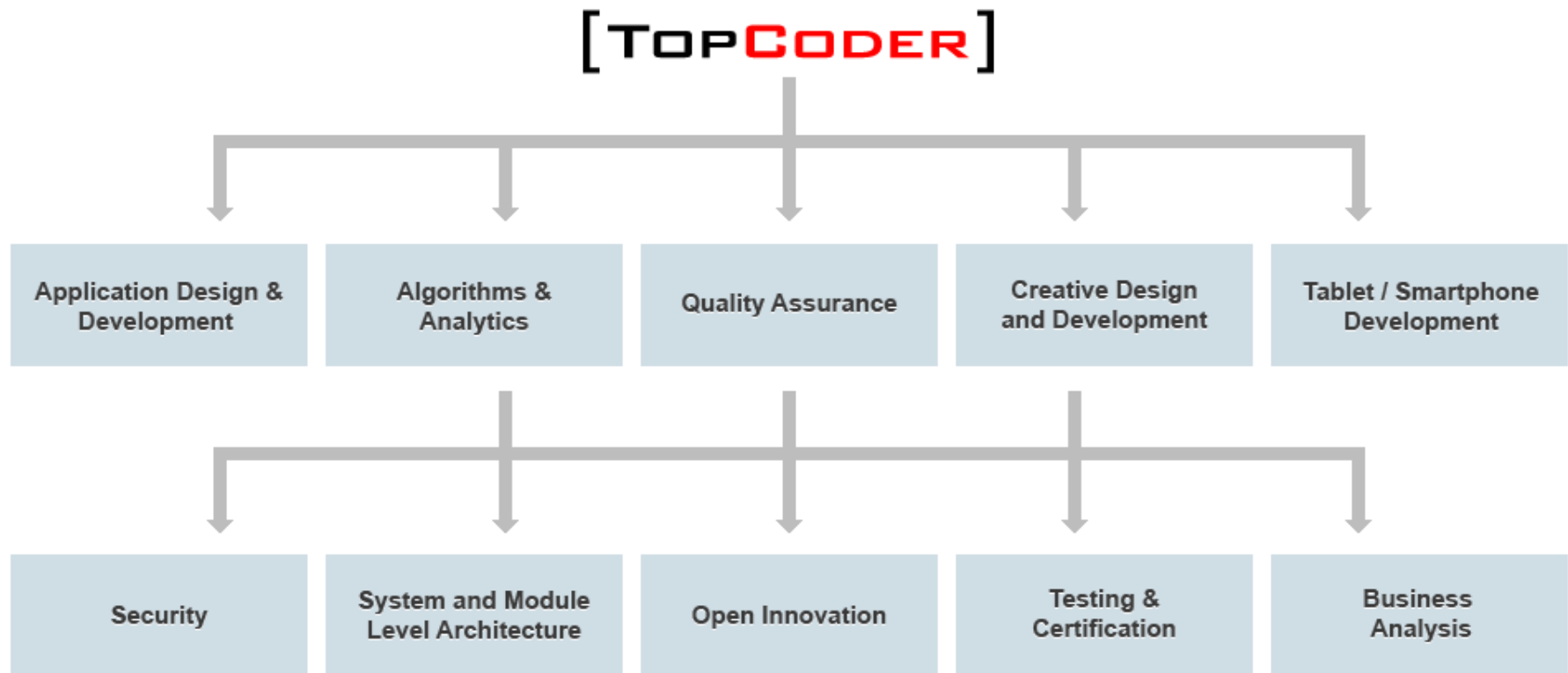
A PLATFORM FOR INNOVATION

OVERVIEW

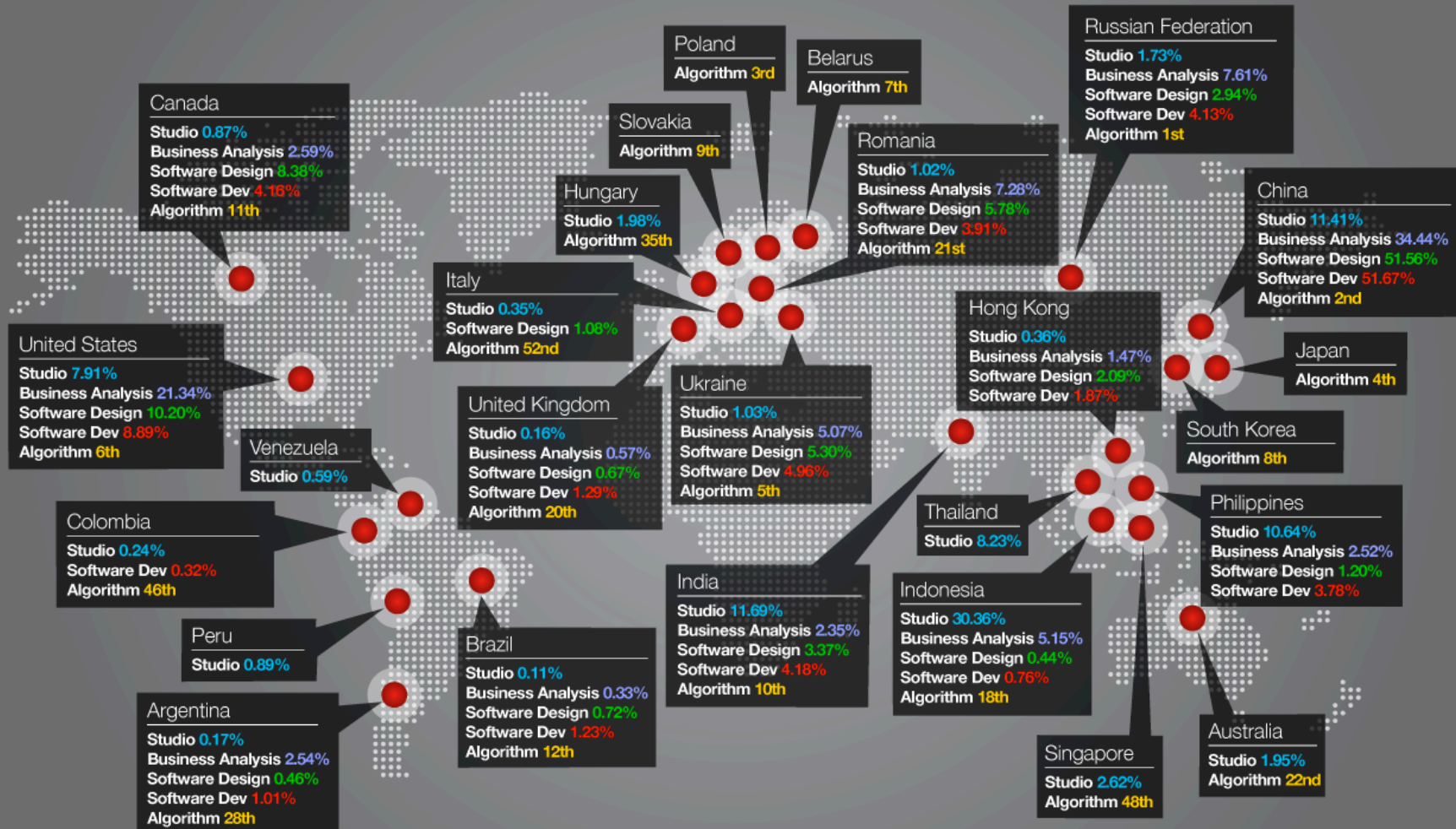


WWW.TOPCODER.COM

TOPCODER COMMUNITY CAPABILITIES



Rank and Winning Percentage by Discipline Across the World

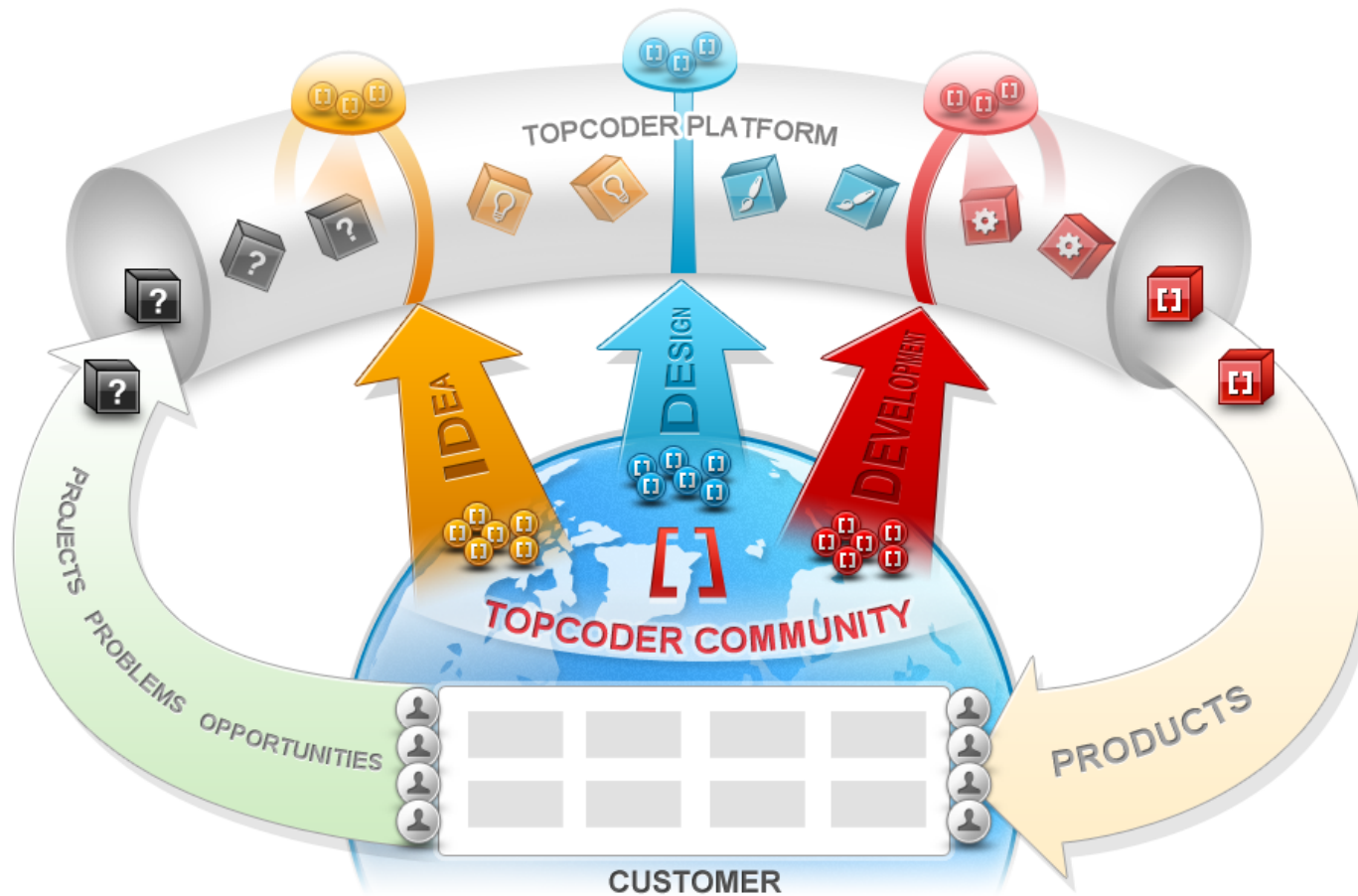


Top registration
countries

Rank and Winning Percentage
by Discipline Across the World

TopCoder
Paid Countries

THE PLATFORM INTEGRATES IDEAS, PROCESS AND PRODUCTS



NASA TOURNAMENT LAB ENGAGEMENT: OUTCOMES

[Algorithm Challenges]

Centered on difficult algorithmic problems like image processing, data compression, prediction. E.g. does not produce widgets.

- :: Competitors try to beat each other's scores in direct, real-time competition, sending in updates frequently.
- :: Typically 2 week contests.

[Software Challenges]

Centered on software development – databases, applications, websites, mobile apps, widgets. Is often “fronted” by open innovation contests.

- :: Competitors submit once, at the end of the contest.
- :: Submissions are scored on scorecards. Highest score wins.
- :: Typically 2 week contests.

[Algorithm Challenges]

Open calls for great ideas. Stakeholders select winning submissions.

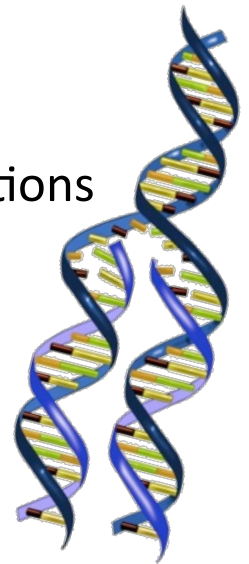
- :: Many ideas can receive a “bounty”, or one submission can win.

TOPCODER ALGORITHM CHALLENGE OUTCOMES



HARVARD MEDICAL SCHOOL: SEQUENCE ALIGNMENT

- » Target was a tool that calculates the edit distance between a query DNA string and the original DNA string
- » Query string is subject to random additions, deletions and mutations
- » Number of permutations made it unreasonable to try them all
- » Goal was to design heuristics to allow for as many sequence evaluations as possible within a time limit



Problem Details:

- » Given three strings of DNA sequences, A, B, C, and “query string” Q, the task is to, for each query string q, "recover" three strings a, b, and c (belonging to A, B, and C) which form a concatenation $a+b+c$ as close as possible to q. Algorithms are scored based on edit distance achieved and computation time, with an emphasis on the former.

HARVARD MEDICAL SCHOOL: SEQUENCE ALIGNMENT

Harvard's Challenge



- Target was a tool that calculates the edit distance between a query DNA string and the original DNA string
- Real-world problem, where the limitations of existing tools severely constrain the ability to pioneer new advances in medical knowledge
- Best known solution, MegaBLAST, processed 100,000 sequences to a high degree of accuracy, yet requiring minutes— **Red dot** on Graph

TopCoder Challenge

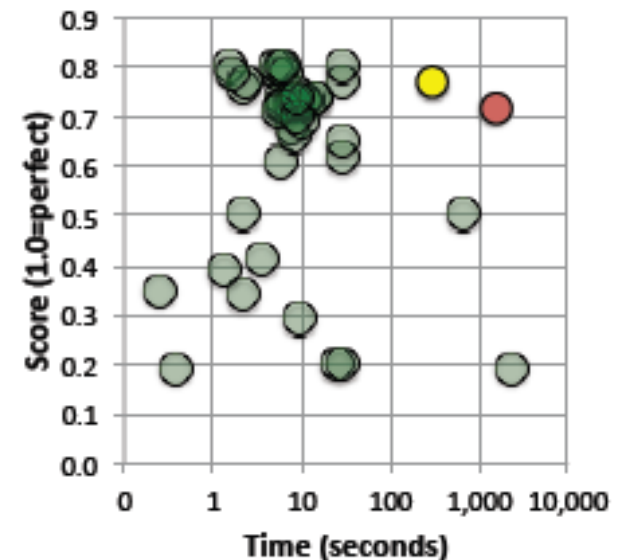
The numbers

- \$6,000 in total prize money
- 733 registrants
- 122 members submitted working solutions
- 654 total solutions submitted – average of 5.4 per person
- Participants spent average of 22 hours working on the problem
- Total of **2,500 hours** of development effort over **2 weeks**

TopCoder Outcome

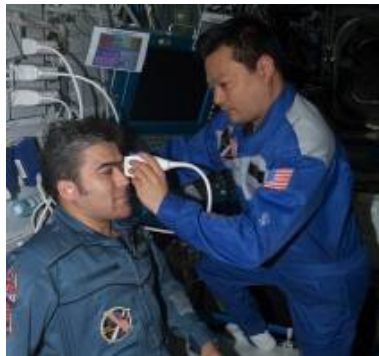
- Winning solution in the competition performs hundreds of times faster with a higher degree of accuracy – **Green dots** on Graph
- Fulltime Resource working for a year, average salary of \$120K - **Yellow dot** on Graph

**Score vs. speed
1e5 sequences**



NASA TOURNAMENT LAB: MEDICAL KITS... IN SPACE

- Given potential medical supplies construct an optimal medical kit
 - Minimize the risk of mission evacuation from a bad health outcome
 - Minimize both weight and volume
 - Each medical supply has additional properties to consider
 - Reusability
 - Effectiveness on range of possible medical events and conditions



- NASA provided simulated medical event data from previous research
- Allowed for accurate evaluation of computed medical kits

NASA TOURNAMENT LAB: MEDICAL KITS... IN SPACE

- Competition ran for 10 days
- 439 total contest participants
- 5,994 code submissions
- Cash prizes and 6 VIP Shuttle launch passes given out
- Winning solution performs kit optimization in 30 seconds, compared to 3 hours for NASA's previous best known solution (**360X**) improvement.
- NASA researchers "blown away" with the results
- Winning algorithm "works like a dream" in its use to redesign the medical kits used in space missions.



NASA TOURNAMENT LAB: PIPELINE THREAT RECOGNITION

- **Detection and classification** of objects in aerial images
- **Algorithmically identify** aerial images that contain potential pipeline “threats”
- Each image needs to be tagged with a **threat confidence level**
- Solutions must efficiently process **tens of thousands of raw images**
- **Potential Research Benefits:**
 - Planetary satellite imagery classification
 - Mars Reconnaissance Orbiter project
 - Federal disaster response and recovery
 - Processing remote sensing satellite data



NASA TOURNAMENT LAB: PIPELINE THREAT RECOGNITION

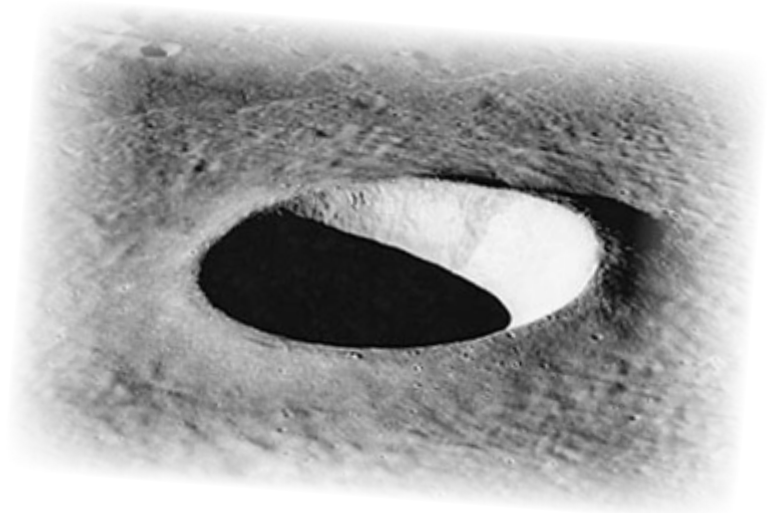
- Competition lasted three weeks
- 1,478 members registered to participate
- 549 total code submissions were performed



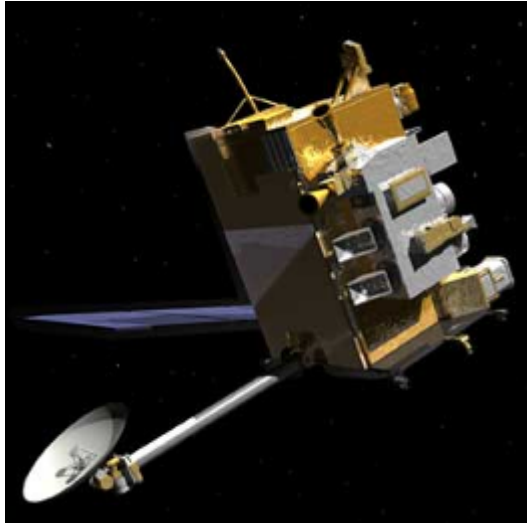
- NASA was very impressed with the top submissions which used “state of the art computer vision approaches”
- NASA identified 3 novel and distinct algorithmic techniques across the various top performers
- Active testing and integration of new ideas and techniques

NASA TOURNAMENT LAB: CRATER DETECTION

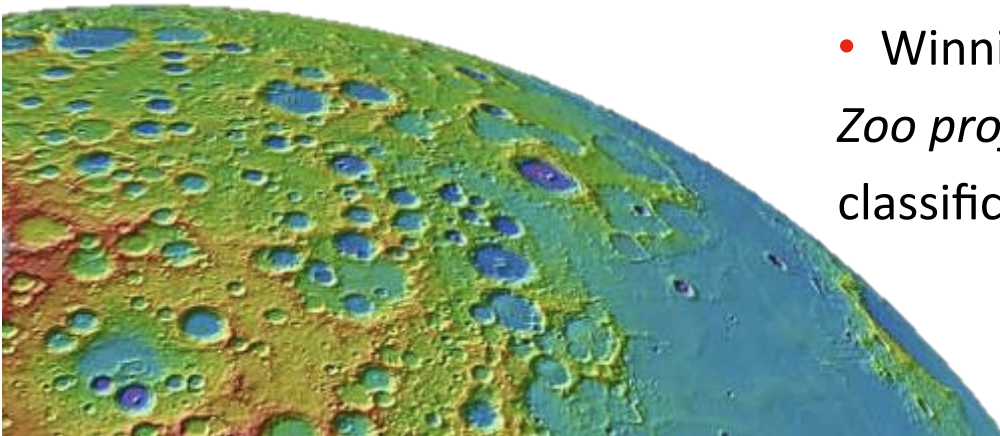
- **Algorithmic detection** of impact craters in lunar orbital images
- More **effectively process** the ever increasing amounts of **orbital imagery** of the Moon, Mars and other planetary bodies
- Competitor solutions provide coordinates of detected craters
- **Potential Research Benefits:**
 - Planet formation and geology studies
 - Align disparate data sets (radar, laser altimetry, etc.)
 - Lander/Rover navigation planning



NASA TOURNAMENT LAB: CRATER DETECTION



- Two week long competition
- \$10,000 in total prizes
- 1,174 competition registrants
- 310 unique submitters
- 8.63 submissions (on average) per competitor
- Integration of final results into NASA framework is in-progress
- Winning algorithms to be shared with *Moon Zoo project* – a crowd-sourced Lunar imagery classification project



NASA TOURNAMENT LAB: USPTO PATENT LABELING

- The Patent and Trademark Office has a huge volume of patents that must be reviewed
- Knowing how some labels on a drawing relate to the patent text is important (the goal is to create hyperlinks)
- Each patent contains different handwriting or font type
- Varied fonts makes it difficult to distinguish between the patent pieces
- TopCoder ran an image processing contest, with success of 70% of the theoretical ideal answer
- USPTO was very satisfied with the result, and we're running a follow up to improve upon the 70%

U.S. Patent Sep. 16, 2003 Sheet 3 of 9 US 6,619,641 B2

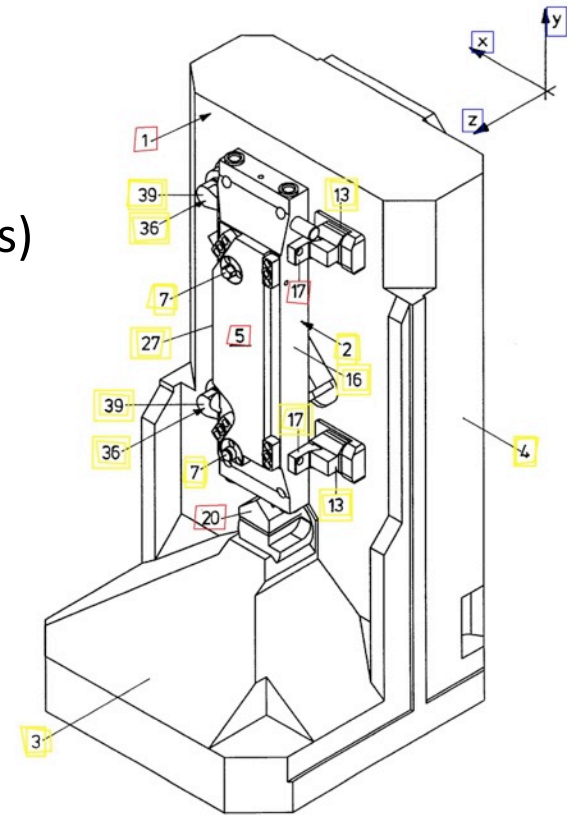


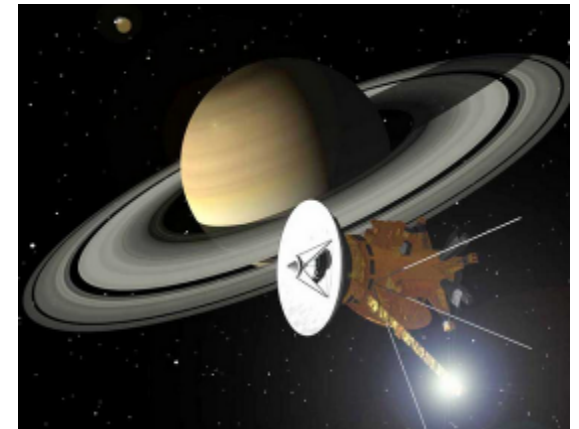
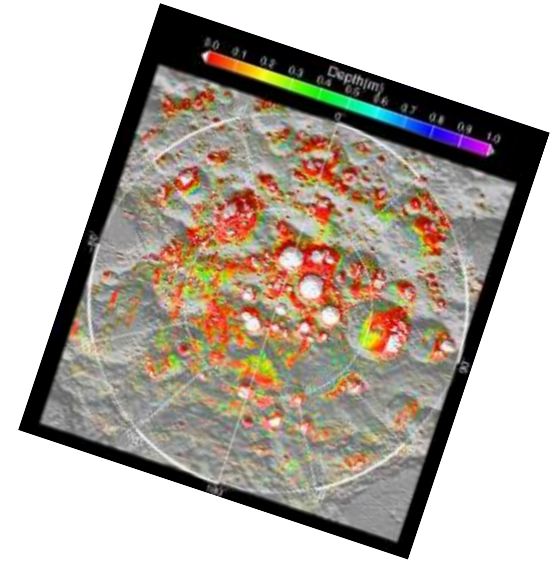
FIG. 3

TOPCODER SOFTWARE CHALLENGE OUTCOMES



NASA TOURNAMENT LAB: PLANETARY “BIG DATA”

- Planetary Data Systems (PDS) captures data from all space vehicles – Orbiters, Landers, Rovers
- Make Planetary Data Systems (PDS) information more accessible and interesting to the public
- Leverage **competitive ideation process** for generating new concepts
- Leverage **competitive software development** contests for building new ideas
- **Architecture** contests for **data reorganization** to achieve accessibility
- “Mashup” Development contests to create compelling mobile and consumer applications to showcase data capabilities.



PDS MASHUP: DIRECTED INNOVATION

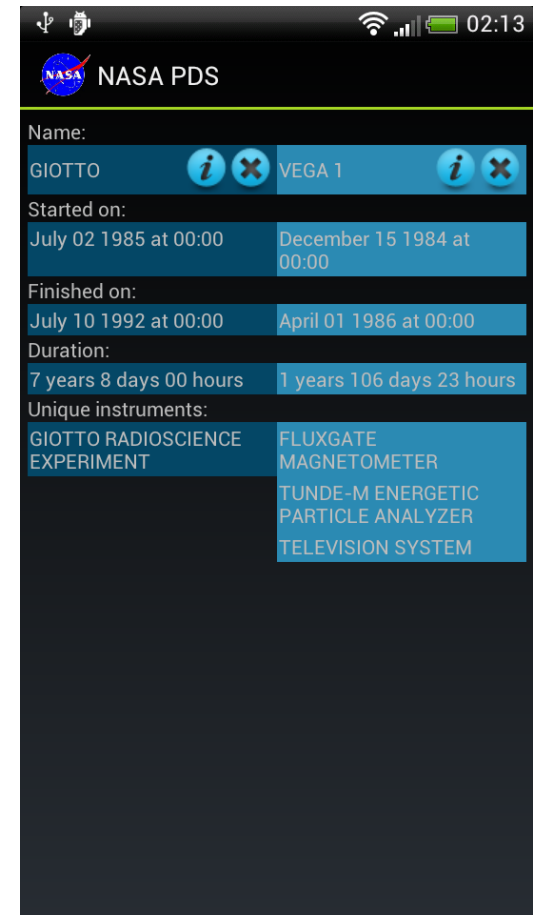
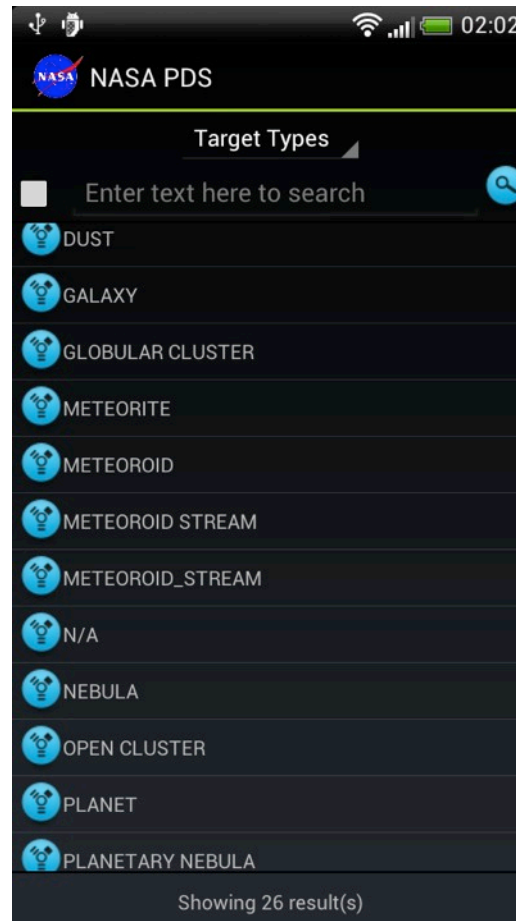
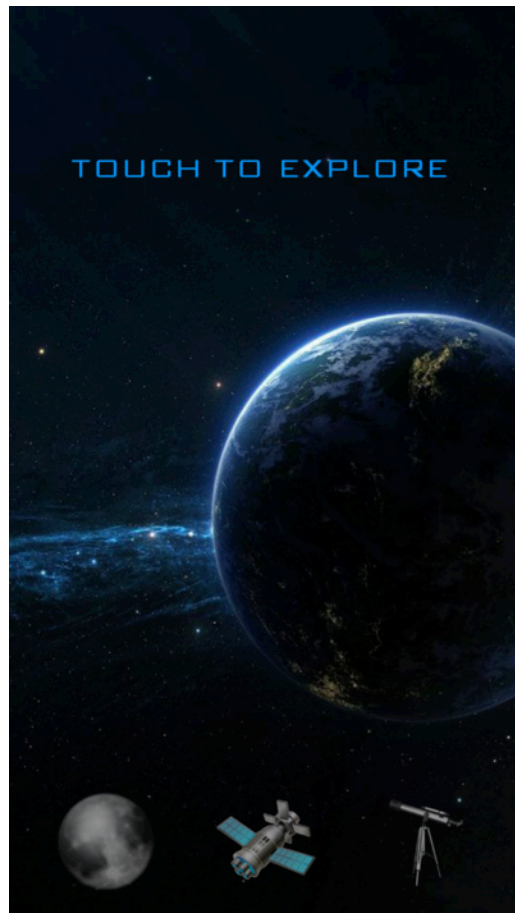
Open “Mash-up” Development Contest –

\$10,000 Prize, 2 weeks

Required to use API built in previous challenges.
Permitted to use other sources too.

#1 requirement was “Joy to Use”

Catered to Android & iPhone



PDS: ALSO FURTHERING STEM GOALS

NoNameSite: engage kids in STEM through community and game-like activities. Launched Sept. 2011 on a DARPA grant.



- If your goal is to engage kids, get ideas from kids!
- Two contests: Idea Generation, Development
- Idea Generation led to first PDS Facebook presence.



NASA TOURNAMENT LAB: PORTABLE/MOBILE EKG APP

- Create a mobile, Android-based 12-lead ECG data viewer
- Advance cheap, mobile medical applications
- Implications for both space medicine and for third-world countries
- Leverage grade school education programs for complex interface design
- Utilize range of competition types for full application build



DARPA INSPIRE PROGRAM: ZERO ROBOTICS



- Spherical satellites move with independent control of all six degrees of freedom in zero gravity (inside the international space station)



- These “spheres” travel within a defined area to complete tasks in a game scenario developed by researchers at MIT

- High School students compete against one another to earn the most points using a high-level language environment

- Virtual zero-gravity and visual simulation is used to allow online competition before the finals are executed on the space station

- Zero Robotics infrastructure and web site was build by TopCoder

